MNE6124: ADVANCED MICRO/NANO ROBOTICS

Effective Term
Semester A 2025/26

Part I Course Overview

Course Title
Advanced Micro/Nano Robotics

Subject Code
MNE - Mechanical Engineering
Course Number
6124

Academic Unit
Mechanical Engineering (MNE)

College/School
College of Engineering (EG)

Course Duration
One Semester

Credit Units
3

Level
P5, P6 - Postgraduate Degree

Medium of Instruction
English

Medium of Assessment
English

Prerequisites
Nil

Precursors
Nil

Equivalent Courses
Nil

Exclusive Courses
Nil

Part II Course Details

Abstract
Micro and nano robotics is an interdisciplinary field which involves microfabrication, robotics, medicine and materials science. This course will cover the basic principles in design, modelling fabrication, and control of miniature robot and

micro/nano-manipulation systems. In addition to basic background material, the course includes case studies of current micro/nano-systems, challenges and future trends, and potential applications. The course will focus on a team design project involving novel theoretical and/or experimental concepts for micro/nano-robotic systems with a team of students. Depending on the nature of the topic chosen, these projects can also involve review of literature, design of new micro/nano robots, simulation or experimental demonstrations.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Understand the unique challenges due to the scaling factor in micro/nano robotics and automation at micro/nano scales.		x	x	
2	Review the micro/nano robotic technologies and MEMS design principles to form a knowledge base for addressing the challenges at micro/nano scale.		x	x	x
3	Apply suitable theories and fabrication techniques to achieve automated manipulation of micro/nano objects, (such as biological cells, micro/nano particles).			x	x
4	Solve practical problems within the emerging multidisciplinary areas (such as biomedical engineering, pharmaceutical applications) where extensive background knowledge and different perspectives of thinking are needed.			x	x

A1: Attitude
Develop an attitude of discovery/innovation/creativity, as demonstrated by students possessing a strong sense of curiosity, asking questions actively, challenging assumptions or engaging in inquiry together with teachers.

A2: Ability
Develop the ability/skill needed to discover/innovate/create, as demonstrated by students possessing critical thinking skills to assess ideas, acquiring research skills, synthesizing knowledge across disciplines or applying academic knowledge to real-life problems.

A3: Accomplishments
Demonstrate accomplishment of discovery/innovation/creativity through producing /constructing creative works/new artefacts, effective solutions to real-life problems or new processes.

Learning and Teaching Activities (LTAs)

	LTAs	Brief Description	CILO No.	Hours/week (if applicable)
1	Lecture	Take place in a classroom setting and consists of lectures and student group discussions.	1, 2, 3, 4	2 hours/week

2	Tutorial	Case presentation will be given to trigger the sparkles of thoughts in proposing innovative solutions for multidisciplinary problems. In-classroom quiz will be involved to strengthen the students' understanding of micro/nano robotic technologies.	1, 2, 3, 4	1 hour/week

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks ("-" for nil entry)	Allow Use of GenAI?
1	Project Presentation and Result	1, 2, 3, 4	30	-	Yes
2	Project Report	1, 2, 3, 4	20	-	Yes

Continuous Assessment (%)

50

Examination (%)

50

Examination Duration (Hours)

2

Minimum Continuous Assessment Passing Requirement (%)

30

Minimum Examination Passing Requirement (%)

30

Additional Information for ATs

For a student to pass the course, at least 30% of the maximum mark for both coursework and examination should be obtained.

Assessment Rubrics (AR)

Assessment Task

Examination (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion

Written exam at the end of the semester.

Excellent

(A+, A, A-) High

Good

(B+, B, B-) Significant

Fair

(C+, C, C-) Moderate

Marginal
(D) Basic

Failure
(F) Not even reaching marginal levels

Assessment Task
Project Presentation and Result (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion
Include 3 parts on oral, lab demo and written report.

Excellent
(A+, A, A-) High

Good
(B+, B, B-) Significant

Fair
(C+, C, C-) Moderate

Marginal
(D) Basic

Failure
(F) Not even reaching marginal levels

Assessment Task
Project Report (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion
Group reports but to include individual discussions

Excellent
(A+, A, A-) High

Good
(B+, B, B-) Significant

Fair
(C+, C, C-) Moderate

Marginal
(D) Basic

Failure
(F) Not even reaching marginal levels

Assessment Task
Examination (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion
Written exam at the end of the semester.

Excellent
(A+, A, A-) High

Good
(B+, B) Significant

Marginal
(B-, C+, C) Moderate

Failure
(F) Not even reaching marginal levels

Assessment Task
Project Presentation and Result (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion
Include 3 parts on oral, lab demo and written report.

Excellent
(A+, A, A-) High

Good
(B+, B) Significant

Marginal
(B-, C+, C) Moderate

Failure
(F) Not even reaching marginal levels

Assessment Task
Project Report (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion
Group reports but to include individual discussions

Excellent
(A+, A, A-) High

Good
(B+, B) Significant

Marginal
(B-, C+, C) Moderate

Failure

(F) Not even reaching marginal levels

Part III Other Information

Keyword Syllabus

Scaling of dimensions, actuation at micro/nano scales, microscopy imaging, electron microscopy, micro/nano fabrication, micro assembly, bio-microrobotics, bio-mimetic microrobots, nanorobotic manipulation, bio-MEMS, microrobotic manipulation.

Reading List

Compulsory Readings

	Title
1	Nil

Additional Readings

	Title
1	Micro-/Nanorobots, by Bradley J. Nelson, Lixin Dong, Fumihito Arai, Chapter 27 from Springer Handbook of Robotics, 2016 Ed.
2	Micro- and Nanomanipulation Tools, by Yu Sun and X.Y. Liu, Wiley-VCH, 2015.
3	Nanopositioning Technologies: Fundamentals and Applications by C.H. Ru, X.Y. Liu, and Yu Sun, Springer-New York, 2016.
4	Fabrication and Characterization in the Micro-Nano Range, by Lasagni, Fernando A., Lasagni, Andrés F. (2011 Eds.)
5	Foundations of MEMS, by Chang Liu, Pearson Education Asia, 2012.
6	Fundamentals of BioMEMS and Medical Microdevices by Steven Saliterman, 2005.